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Knowledge intensive entrepreneurship from firm exit in a high-tech cluster: the case of the wireless communications cluster in Aalborg, Denmark

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Introduction

This chapter addresses how the existence of a cluster of firms with a specific knowledge base in a region affects future knowledge intensive entrepreneurship (KIE) in that region. Focusing on spinoff activities, the case of the wireless communication cluster in North Jutland in Denmark demonstrates how entrepreneurs develop knowledge, skills, routines, social capital and networks while working in an industry and then go on to use these resources to create new business in the same or related industries in the same approximate location.

Various studies show that spinoffs, firms established by entrepreneurs with prior experience gained from existing firms in the same industry, perform better than other types of start-ups (see, for example, Dahl and Reichstein, 2007). It is believed that when the founder has pre-entry experience in the industry, relevant routines, skills and knowledge are transferred from the incumbents to the new firms, providing a competitive advantage to spinoffs as compared to other entrants into the industry. Since spinoffs tend to locate close to the 'parent' companies and perform better than other entrants, spinoff activities often lead to the

geographical clustering of firms. This means that the existing industry structure of a region may affect the development of that industry in that region in the future. Empirical studies of the semiconductor industry in Silicon Valley, automobile industry in Detroit, tire industry in Akron and the high-tech cluster in Cambridge, UK illustrate this mechanism quite well (Klepper, 2010; Buenstorf and Klepper, 2009; Garnsey and Heffernan, 2005).

The main purpose of this chapter is to illustrate knowledge intensive entrepreneurship following firm exit in a declining high tech cluster. More specifically, it shows how the entrepreneurs' knowledge of markets, products, technologies, unmet customer demand, competitors, suppliers and skills gained from pre-entry experience affect their search for and utilization of new business opportunities. Unlike studies focusing on the spinoff activities that drive the formation of clusters, however, this chapter intends to take a closer look at spinoff activities in a declining cluster originating from company closure.

The chapter investigates KIE in the wireless communications cluster around the city of Aalborg in northern Denmark. The cluster consists of firms in the field of maritime communication and navigation, telecom and land-based satellite communications equipment, and mobile and cordless communication. This comprises a high technology knowledge intensive industry characterized by fast technological change and a growing global market. The first company here was established back in the 1960s, but the main growth in the cluster occurred during the 1990s, when the 15 firms grew to 40. The cluster peaked in 2003 with 50 firm employing 4,500 people. Recently, the turbulence in the global wireless communications industry coupled with financial crisis hit the cluster hard and caused downsizing and even exit of firms. This caused a wide spread fear in the regional economy that the closure of many firms would lead to loss of well-paid jobs for highly educated persons. However, as we will show in this case, the negative process also led to the establishment of new firms. In 2009, a research and development subsidiary of Motorola located in the cluster closed down. About 275 employees were laid off, but at the same time 20 new firms were founded by former

employees. The case to be studied in detail is the KIE following the closure of the Motorola subsidiary in the context of a declining cluster. It will describe how these firms were founded and explore relations in general between the previous company and the new firms. Then, one of the new firms is chosen for a more detailed description of this type of knowledge intensive entrepreneurship.

The key questions are:

- How do the existing firms and knowledge base affect future KIE?
- To what extent does knowledge diffusion take place through KIE from existing firms?
- How did the entrepreneurs' pre-entry experiences influence their new venture?
- What effect does KIE from firm exit in one industry have on other industries in the region?

The case: KIE in a high-tech cluster following firm closure

This section starts with a brief history of the wireless communication cluster by way of an introduction to the past KIE pattern. There follows a description of KIE after the closure of Motorola in 2009. The rapidly changing landscape of the mobile communication industry in recent years and the process of closure will be presented before KIE by the spinoffs are described in detail.

Earlier spinoff activities in the cluster

The development of the wireless communication cluster in Aalborg, Denmark was always highly characterized by spinoff activities. The very first firm in the cluster, S.P. Radio, had diversified into wireless communication equipment for maritime use (small and medium sized vessels) in the early 1960s. The company was very successful and its products were considered technologically more advanced than those of the few competitors

at the time. In 1973, three engineers from S.P. Radio established the first spinoff company, Dancom, producing maritime communication equipment. In 1977, two engineers from Dancom founded Shipmate, which also produced radiophones for maritime use. Shipmate developed a very successful satellite navigation system in 1981 at a third of the cost of its competitors and subsequently grew from three employees to 200.

Dancom went through severe financial difficulties in the early 1980s and was restructured and renamed Dancall Radio in 1983. At the same time, the company diversified into the related market of onshore mobile communications. Dancall grew quickly in the 1980s following the opening of the market based on the new common Nordic standard for mobile telephony (NMT). The size of Dancall and its technological base in the growing market for mobile phones and other wireless communication technologies made it a main seedbed of KIE in this cluster. The firm went through several crises and owners, but continued through the 1990s and 2000s to be a key company in the cluster, with many of the local entrepreneurs in the industry coming from this company. Shipmate, meanwhile, also expanded into mobile communications with the purpose of exploiting the promising business opportunities in the new market, through the establishment of a company named Cetelco. Cetelco developed its first NMT phone in 1986 and began to develop and produce mobile phones for several European and East Asian countries. In the 1980s and early 1990s, several spinoffs arose from Dancall and Shipmate, such as Danish Marine Communication (1980), Ammcom (1986), T-COM (1987), BD consult (1988), LH Mobil Radio (1991) and Gatehouse (1992). The founders of these firms often list new market opportunities not followed by the parent company or disagreement with the company strategy as reasons for starting their own ventures.

In the late 1980s, the work on a common European standard for mobile telephony (GSM) began. Dancall and Cetelco established a joint venture, DC Development, to develop the basic modules of a GSM phone together with Aalborg University at the local science park, NOVI. DC Development succeeded in developing the basic technologies, and these parent companies were among the first to introduce a GSM

phone, in 1992. By this time Cetelco had more than 100 employees, but it faced financial problems and was gradually taken over by the German company Hagenuk, in 1988-90. Dancall had grown to more than 600 employees by 1993, but it too went into financial difficulties and sold its cordless telephony division. The problems continued, however, and Dancall was taken over by Amstrad, and then, in 1997, acquired by Bosch, which wanted to enter the industry and grew it to 1,700 employees by 1999. A year later the company was split into two, with the production side sold to Flextronics, and the R&D to Siemens.

The wireless communication cluster grew rapidly in the 1990s with its competences in the GSM standard attracting various types of start-ups, including parent spinoffs (spinoffs owned by existing companies), but which mainly represented multinational corporations (MNCs) acquiring local firms or making green field investments. Motorola was one of the MNCs to create a subsidiary in the cluster so as to access the specialized knowledge of workers in the mobile telecommunication technology there. The cluster started to decline when the new standard (3G) emerged, however, mainly due to a lack of competences in the new technologies. After the peak of 2003, the number of firms and employees in the cluster started to drop, a decrease that continued with the (ongoing) major changes in the industry and the financial crisis from 2007. The decline of the cluster intensified when Motorola and Texas Instruments closed down in 2009. At the time of writing, the cluster consists of 45 firms employing some 2,300 people, together with a university and science park. The next section explains the changes in the industry that led to the Motorola closure.

Turbulence in the mobile communication industry

The introduction of the iPhone and Android smart phones in 2007 and the subsequent rise of new competitors proved to be a disruption to the mobile phone industry. These were 'disruptive' technologies in the sense of significant changes in the basic technologies that effect an alteration of the pattern of the existing industry. Christensen (1997) describes the disruption as not necessarily brought about by the new technology itself, but

often coming from the new business models, applications or customers that follow the introduction of the new technology. The disruption often comes from new firms entering the industry and the outcome is often a shift of market leaders and location (Utterback 1994). The Apple's iPhone OS (iOS) and Google's Android operating system radically changed the industry. The iPhone was initially not considered to be a good product by many of the traditional mobile phone companies in terms of its functioning as a phone, but together with the new technology it managed to change the entire industry in the years that followed.

According to Gartner, the market shares of the mobile phone market in 2008 were: Nokia 38.6 per cent, Samsung 16.3 per cent, Motorola 8.7 per cent (dropping from 14.3 per cent in 2007), LG Electronics 8.4 per cent, and Sony Ericsson 7.6 per cent, while Apple sold 11,417,500 units, or 0.93 per cent. In 2011, Nokia's overall market share of mobile phones had dropped to 23.8 per cent followed by Samsung (17.7 per cent), Apple (5 per cent) and LG electronics (4.9 per cent), while Motorola had fallen to 2.3 per cent market share. The sale of smart phones reached 31 per cent of the total number of mobile phones sold in 2011. The dominating operating system in the fourth quarter of 2011 was Android (50.9 per cent) followed by Apple's iOS (23.8 per cent) and Nokia's Symbian (11.7 per cent).¹

The financial crisis also created problems in the industry. Commencing in 2007 in the US housing sector and financial industry and drastically worsening in September 2008, when Lehmann Brothers collapsed, the crisis then spread to the real economy causing an almost worldwide recession. Sales of mobile phones were adversely affected, especially in the West where consumer confidence plummeted. In Denmark the unemployment rate rose from 2 per cent in the summer of 2008 to 6.5 per cent in January 2010, while GDP growth was at -1.1 per cent in 2008 and -5.9 per cent in 2009 (the worst recession in the Danish economy since the Second World War).

Focusing on rather traditional mobile phone technologies, Motorola in particular faced a survival challenge during this phase of disruption. This worsened during the economic crisis which created a rather unfriendly business environment. This is illustrated in more detail in the next section.

Closure of Motorola in the cluster

Motorola had entered the cluster in 1999 by acquiring a local firm called Digianswer. In 2006, it acquired the activities of BenQ in the cluster, which had taken over Siemens' activities there in 2005. It also acquired TTP Com's subsidiary in the cluster, which had been founded by former Siemens employees and operated as a supplier to Motorola. Motorola's Aalborg division focused on development of new mobile telephones and preparation of the production (initiating ramp- up production and finding production partners). As a result of the severe trouble in which Motorola found itself, the company headquarters decided to restructure the division, shift to the Android platform and reduce the number of newly developed models. Then it decided to move out of the European mobile market altogether, and Motorola in Aalborg was closed down.

The closure of Motorola in Aalborg was announced in November 2008, its 275 employees laid off in mid-December and the company officially wound up at the end of March 2009. At first the local management contacted Invest in Denmark and made a list of potential companies that might be able to take over the operation. Then it started to contact these companies by formal and informal channels. The formal assignment was to recoup the fixed capital (selling the equipment, buildings etc.) , but the management also worked on a strategy to help the employees find employment or start new firms if the continuation of the company as a whole was to fail.

The management organized a seminar with 34 local and national firms to help the employees back to work. It also held an idea generation seminar and invited entrepreneurs and local entrepreneurship organizations to explain various ways to start a new company. The seminar generated many good ideas for

new firms and also created connections between the former employees and the invited companies. The employees received up to six months full salary when they were laid off. Despite the troubled economic situation, 24 per cent of the employees had found a new job by February 2009, a share that had risen to 40 per cent by June and 52 per cent by August. And former Motorola employees also founded several new companies.

Knowledge intensive entrepreneurship by former Motorola employees

Twenty new companies were founded by ex-Motorola employees during the period 2008–2010, and two parent spinoffs were also attracted to the region. Regarding the latter, the US based company Molex founded a subsidiary by taking on a group of employees with special competencies in antenna technology. The head of the antenna unit at Motorola Aalborg started in November 2008 to look for a firm to take over their group if a takeover of the division failed. He had worked many years in building the group of employees with unique antenna competencies and acquiring equipment. Making use of their network, they ended up contacting Molex, with whom they had worked previously as a supplier. As a result, Molex took on seven employees, acquired the specialized equipment and rented office space in the old Motorola building. Today they develop, design and test antenna solutions and have a joint project with Aalborg University on 4G LTE antennas. This type of entrepreneurship has an established history in the cluster, where several parent spinoffs have been founded by local engineers. Mobility in teams is also a frequent phenomenon when companies close down since employers look to take on well-functioning units. The Finnish company Ixonos also founded a parent spinoff at the NOVI Science Park in Aalborg, employing some of the former Motorola employees working on Android solutions.

Compared to Motorola, the two new parent spinoffs are more specialized, focusing on certain (antenna and software) functions of mobile phones. Moreover, both companies are engaged in developing technological competences in rather new systems such as 4G and the Android operating system. Therefore, we

can conclude not only that KIE in the form of parent spinoffs (subsidiaries) secured the continuation of the existing competences stemming from Motorola, but more importantly, that the influx of new competences from the parent firms advanced the further development of existing competences towards the new, now dominant mobile communication systems.

Regarding the 20 new companies, these employed a total of 44 employees including the founders. Seven of the start-ups can be labelled as hobby start-ups since the founder has a regular job in another firm. Most of the companies are based on the entrepreneurs' pre-entry experiences. However, only four of them can be characterized as spinoffs in the cluster following a narrow definition of the cluster, that is, including only firms dealing with wireless communications technologies. Many of them used their competencies in software development gained at Motorola to establish companies in the broader ICT sector (see Table 1). These mostly work on developing software for other companies as IT consultants. For example, PCB-Support was founded by printed circuit board (PCB) designers working on PCB design, while Code Craft was founded by software engineers developing software for a broad range of customers.

Other firms established after the Motorola closure also show how entrepreneurs' knowledge and experience gained in former job functions at the defunct operation may be transferred to new firms. A technician, a senior design engineer and a metrology engineer founded a company called 3D-CT, which specializes in CT measuring. While working in Motorola, they were the first to be introduced to CT technology in the mobile industry and in Denmark. When Motorola closed down, they bought the CT scanners from the company and started providing consultancy services. The former director of the division established a management consulting firm specializing in helping firms through the liquidation process. He continues to draw on his experience of managing rounds of layoffs and the process to final close-down, and including the organization of job-searching seminars for the laid-off employees.

All the spinoffs created from Motorola's exit are presented in Table 1. As most of the firms were created outside the wireless cluster, this illustrates that there has been knowledge dissemination from the wireless communication industry to other adjacent industries through KIE. Furthermore, a high correlation between the former position in Motorola and the new ventures indicates that the competences gained in Motorola are highly utilized in the new firms, which demonstrates transferability of the competences to other industries.

Table. 1 Spinoffs by former Motorola employees

Firm name (Founding year, exit year)	Industry	Jobs	Founder's prior position(s) at Motorola	Field of activity
3D-CT (2009)	Other	7	Technician, Senior Design Engineer, Metrology Engineer	Measurement centre with CT scanner
Arcane labs (2009)*	ICT	2	Software Engineer/Team Leader, System Engineer	X-box games, Classiccard games
Cloud Circus (2010)	ICT	5	System Engineer	Software development
Code craft Aps (2008)	ICT	3	System Engineer	Software development
Createitreal (2009)	ICT	1	Project Leader Engineering	Developing 3D printing and automated fabrication technologies
Flexmanagement (2010)	Others	1	Director	Management consulting
Full circle design.dk (2009, 2010)	ICT	1	Product Manager	Embedded UIs, Documentation of UI Design
Huge Lawn software (2009)	Wireless	5	Quality Manager	iPhone and iPad applications
MVC-data (2008)	Wireless	2	Senior Software Engineer	SW and HW development , solutions with Bluetooth technology
NeoGrid Technologies (2010)	ICT	3	Line manager, Function manager	Solutions for controlling electricity demand
NordicRefurb (2009)*	Others	1	Department Manager	Electronic test and manufacturing equipment.
North Development consult (2009, 2009)	ICT	1	Senior Electrical Engineer	Engineering consulting
OR Pro (2009)*	Others	1	Requirement Manager	Project management
PartDesign (2009)	Others	2	Sourcing manager, Mechanical project leader	Mechanic construction, FEM analysis, Sourcing in China
PCB-support (2009)	ICT	2	Printed Circuit board (PCB) Designer	PCB design
Print s.m.b.a. (2009)*	ICT	2	Project Leader , Program Manager	IT consulting
SES IT (2010, 2010)	ICT	1	Software Test Engineer	IT consultant
Synergile (2008)*	Wireless	1	Engineering Lead	RF Engineering solutions
Unpaq (2009)*	Wireless	1	Software Engineer	Software, Mac OSX, iPhone
Utopia Solutions (2009)*	ICT	2	Software Engineer	Web shops and custom web-solutions

* Hobby start-ups: The founders have regular jobs in another company.

How an entrepreneurial spinoff is born from an existing company: the story of Huge Lawn

Software

In this section, entrepreneurial process of one specific spinoff company, Huge Lawn Software, will be described in detail to show how the founder developed a business idea from his experiences in an existing firm and how firm closure provided a good opportunity to start up a venture. Describing the detailed process of venture creation, this story highlights knowledge dissemination through KIE, showing that knowledge from an incumbent is kept and further developed in the cluster in spite of firm closure.

Uffe Koch, the founder of Huge Lawn Software, has an engineering education with specialization in IT and computer technology. He was working in British TTPCom's local subsidiary when Motorola acquired the firm, in 2004. TTPCom developed mobile phones and software for other firms and Motorola was one of their biggest customers. When the firm was acquired by Motorola, Koch had high hopes of the opportunities that Motorola would bring as one of the major companies in the industry. However, the software that he and his colleagues had worked on for many years was given a low priority compared to the other projects already running in Motorola and in the end the project was completely curtailed. It was about then that he realized the potential of iPhones (smartphones). He tried to convince Motorola that the company needed to pay more attention to the new technologies for smartphones, but he did not succeed.

When his ideas were not accepted in the Motorola, Koch started to think about establishing his own company, to develop applications and other small programs for smartphones. He started investigating how to start up a business and took a (weekly) course in entrepreneurship. In this way, he was taking the first step toward starting his own business while he was still employed at Motorola. When the news on the closure of Motorola came out in 2008, he had already decided to quit his job and had written a letter of resignation. However, it turned out that, due to his seniority in the company, he could get a half year's full salary from the time of closure. He decided to utilize this opportunity to realize the idea of establishing his own company. Since

he had been developing the idea and had prepared for the opportunity, he was able to start as self-employed from the day he lost his job at Motorola.

The local entrepreneurship organization offered 12 hours of consulting for a good price and Koch took the offer to bring the idea into practice. Although he had experience in developing applications and software for a different operating system, he decided to enter the market for iPhone applications as he found the Apple development tools and environment exciting and saw huge business opportunities in this market. He knew that he had the relevant knowledge, experience and not least network to make this work. In the starting phase, Huge Lawn Software was mostly hired to develop applications for large company and organization marketing. These apps were distributed free to customers and other stakeholders, and Huge Lawn Software was paid for the development work directly by its customers. However, in some cases, some applications developed for marketing purposes were found to be unique and so useful that they were sold in Apple's app store and even became very popular as a category in their own right. The company grew quite quickly and three in-house developers and various freelancers were hired. Since its foundation, this company has developed, among others, an interactive application for a major Danish radio station, a weather forecasting application for a windmill company and an application for a campaign that the National Board of Health is running. In 2012, it announced that it now is also capable of developing Android apps.

Conclusions

The case in this chapter describes KIE in the form of spinoff activities in the wireless cluster in a region of northern Denmark. To start with, the history of the cluster showed that firms that were successful in a certain industry have created spinoffs of many generations that diversified into related fields. The KIE was indeed the driving force behind the formation of the cluster, and this demonstrates how existing firms and the knowledge base affect future KIE.

Moving on to the focus of the case, namely the KIE from the exit of Motorola in the cluster in 2009, a similar pattern of spinoff activities is observed. The spinoff pattern shows that the knowledge and the experience gained by the founders in the former workplace contributed positively to new venture creation. Firstly, most founders established new firms in either the same wireless communications industry or the related ICT industry. As most of the employees in Motorola were R&D engineers, the technological competences that they possess were transferred to the new company, which is clearly shown in their choice of industry. It is also apparent that there is a connection between the former job functions in Motorola and the services and products that the new firms provide. Most of the spinoffs are consulting firms that offer services that fall within their competences utilized in their old jobs. Software developers and hardware developers founded consulting firms that offer consulting within software development and hardware development, respectively; a technician who used to work with CT technology on the measurement of industrial products took over the equipment from Motorola and started a company measuring diverse industrial products for customers.

Moreover, the knowledge the founders accumulated on the market and the industry also helped them detect good business opportunities. In the case of Huge Lawn Software, the founder spotted a lucrative business opportunity in the iPhone app market because he was engaged in developing software in one of the biggest mobile phone producers in the industry. He knew exactly how the industry and the technologies were developing in this field. Not only did he have the skills to try out Apple's development tools, but he also had enough knowledge of the market to analyse the business potential of the idea. All this goes to show that existing firms and their knowledge base can strongly affect the future KIE in a region and that the entrepreneur's pre-entry experiences influence the creation of new ventures.

The knowledge diffusion in this case took place through the mobility of the employees released through the Motorola firm closure. To find out to what extent the knowledge diffusion took place through KIE,

it is necessary to take a look at how many of the 275 former Motorola employees found a new job in existing companies and how many participated in KIE through spinoff activities. Out of 247 employees that had found employment as of 2011, 220 people were working in existing companies and 27 had founded new ventures. This means that about 10 per cent of the released workforce from the existing company contributed to the knowledge diffusion by KIE. Thus most diffusion of knowledge would seem to have taken place through the mobility of employees who simply got new jobs. The share of KIE appears to be high given the unfriendly business environment during the financial crisis, but it is uncertain if many of these will survive or grow substantially in the future.

We have also learned that firm exit in one industry has an effect on KIE in other industries in the region. The closure of Motorola created spinoffs, the majority of which were in industries other than that of wireless communications. Only four out of 20 new firms were established within the boundary of the wireless communications cluster. A total of 11 companies can be identified as operating within the broader boundary of the ICT industry, while five firms moved into totally different areas. As many founders utilise their specialised competences in their start-ups, we can assume that the ICT and other unrelated industries will benefit from the knowledge these new firms bring. Thus, knowledge diffusion does take place through KIE from existing firms, but it appears that, in this case of a declining cluster, most KIEs start up in related industries. This is because a declining cluster and the very turbulent mobile phone industry do not favour the entry of small start-ups. However, the KIE from Motorola are to a large extent still based on the existing knowledge base from Motorola.

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¹ Numbers from Gartner reports on 'Market Share: Mobile Devices by Region and Country'. Available at: <http://www.gartner.com>